

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
RENTON, WASHINGTON 98055-4056

In the matter of the petition of

THE BOEING COMPANY

for an exemption from § 25.901(c) of Title 14,
Code of Federal Regulations

Regulatory Docket No.
FAA-2001-10069

GRANT OF EXEMPTION

By letters dated June 29, 2001, and November 8, 2001, Mr. Edgars A. Kupcis, Manager, Certification & ETOPS Programs, The Boeing Company, P.O Box 3707, Seattle, Washington 98124-2207, petitioned for an exemption from the “no single failure criteria” of § 25.901(c) of Title 14, Code of Federal Regulations (14 CFR) as it relates to “uncontrollable high thrust failure conditions.” Recent studies and service experience indicate that some existing transport category airplanes do not strictly comply with § 25.901(c) for certain uncontrollable high thrust failure conditions. The proposed exemption, if granted, would permit type certification of a similarly non-compliant derivative of the current Boeing Model 757-300 airplane to allow installation of alternative Pratt & Whitney 2000 series engines.

The petitioner requires relief from the following regulation(s):

Section 25.901(c) requires in part that “no single failure will jeopardize the safe operation of the airplane.”

The petitioner supports its request with the following information:

“The engine control system for the PW2000 engine family installed on the 757-300 is the same system that is currently used on the 757-200 airplane. This allows the same powerplant to be installed on both the 757-200 and 757-300 models. Minor changes have been incorporated in the system to allow the engine thrust to be increased to 43,000 lbs. This thrust is equivalent to the thrust available on the RB211-535E4B engine on the 757-300 airplane.”

“Two independent means for engine control, identical to those that presently exist in the in-service fleet are maintained. The means are (1) thrust lever for modulating thrust and (2) fuel control switch for turning on and off fuel flow.”

“The engine control system on the 757-200/PW2000 airplane is a mature system. Its architecture, production processes, and maintenance practices have resulted in an excellent service record. There has not been a malfunction incident in the past 7.7 million flight hours. Any architecture changes to the system as a result of the requirement to meet this regulation will reduce its reliability by introducing added system complexity. The 757-200/PW2000 operators are well versed in operating and maintaining the present system. Retention of the extremely reliable 757-200/PW2000 thrust management control system architecture on the 757-300/PW2000 airplane family is in [the] public interest.”

Also, the petitioner agrees to demonstrate that:

- 1) “...all practicable actions have been taken to minimize the adverse effect on safety associated with granting of the exemption from 14CFR 25.901(c) for the 757-300/PW2000 Series Engines.”
- 2) “...the risks associated with granting of the exemption from 14CFR 25.901(c) for the 757-300/PW2000 Series Engines are low....” Specifically, Boeing will demonstrate the following:
 - (a) “The 757-300/PW2000 complies with 14CFR 25.901(c) for any foreseeable uncontrollable high thrust failure conditions in flight, except possibly during approach below 400 feet; and
 - (b) The frequency of occurrence of uncontrollable high thrust failure condition on the 757-300/PW2000 fleet will be less than one per ten million airplane operating hours.”

Notice and Public Procedure Provided

A summary of this petition was published in the Federal Register on July 27, 2001 (66 FR 39222). No comments were received.

The Federal Aviation Administration's (FAA) analysis is as follows:

Background

Uncontrollable High Thrust Failure Conditions

Numerous single and anticipated combinations of failures within traditional turbojet engine control systems result in losing the normal means to control thrust (i.e. control via the throttle lever, autothrottle, etc.). A subset of the resulting failure conditions may include actual thrust either increasing to higher than commanded and/or remaining high when low thrust is commanded. These “Uncontrollable High Thrust Failure Conditions,” and the hazards they pose, have long been inherent in transport airplane designs. In fact, the “fail-safe” states for engine controls have traditionally been chosen to protect high thrust capability and allow the flightcrew to decide when an engine shutdown is appropriate.

An initial estimate indicates that over the last 20 years the average rate of occurrence for the uncontrollable high thrust failure condition on turbofan-powered large transport category airplanes has remained relatively constant at around one every 2.5 million flight hours. This would indicate that to date an “Uncontrollable High Thrust Failure Condition” has occurred hundreds of times without resulting in a single reported serious injury.

When these failure conditions were identified during past certifications, compliance was typically based on accepting an assertion that the flightcrew will recognize and safely accommodate the loss of the normal means to control engine thrust, including shutting down the affected engine via an independent fuel shutoff as required. However, recent engineering studies and service experience, including a 1997 Saudi Arabian Airlines Boeing 737-200 accident, indicate this traditionally accepted assertion is not always valid. For those airplanes re-evaluated to date, the available failure recognition and accommodation time under certain anticipated operating conditions is so short and the required corrective actions sufficiently unnatural that the flightcrew cannot be relied upon to reliably and completely perform those actions before the safe operation of the airplane is jeopardized.

The FAA is responding to this revelation by developing a “Thrust Control Malfunction Airworthiness Program” to consistently and objectively assess and manage the existing and future transport airplane fleet risks associated with this

endemic potential for non-compliance and unsafe conditions. The ultimate goals of this program will be to bring the transport airplane fleet back into compliance as quickly as practicable, while assuring the risks associated with interim non-compliances are managed so that they do not represent unsafe conditions.

In the interim, for type certification the FAA has begun requesting more effective validation of any assertion that the flightcrew will recognize and safely accommodate the loss of the normal means to control engine thrust. Such a request is what led to the subject petition and is likely to lead to many more such petitions until practicable design solutions can be identified, validated, and safely integrated into turbine engine control system type designs.

Boeing Model 757-300 & PW2000 Series Engines

The engine control system for the PW2000 engine family proposed to be installed on the 757-300 is the same system that is currently approved on the 757-200 airplane. The petitioner has indicated that there are several single failures and combinations of failures that can cause a PW2000 series engine to produce high thrust, up to the level where the first independent limiter (governor) is encountered, while not responding to the throttle lever. Further, the petitioner has indicated that this may jeopardize the safe operation of the Boeing 757-300 airplane if it occurs during some particular takeoff or landing conditions.

The petitioner intends to demonstrate that those combinations of failures that could jeopardize safe operation comply with § 25.901(c) in that they are not “probable combinations”. (Note: the term “probable,” as used in § 25.901(c), means “foreseeable,” “anticipated to occur,” or “not extremely improbable” and hence has a very different meaning than the same term as subsequently used in association with § 25.1309(b) compliance.) Conversely, the petitioner does not intend to demonstrate that those single failures which could jeopardize safe operation comply with § 25.901(c). Compliance with § 25.901(c) requires each identified single failure be assumed to occur under all anticipated combinations of airplane operating and environmental conditions. While the single failures themselves must be assumed to occur regardless of their probability, probability can be considered when determining what combinations of operating and environmental conditions are anticipated to occur in the fleet life of the airplane type. Single failures do not need to be assumed to occur under conditions that are in and of themselves not expected to occur. Nonetheless, the proposed design is known to have single failures that will cause uncontrollable high thrust.

Uncontrollable high thrust under certain anticipated takeoff and landing conditions is expected to jeopardize the safe operation of the proposed airplane. Consequently, in order to certificate the installation of the PW2000 series engines on the Boeing 757-300 airplane, the petitioner must either obtain this exemption or substantially modify the associated

engine control system design. As delineated in the petitioners supporting information, the petitioner has concluded that the exemption is the option which best serves the public interest.

FAA Analysis - Introduction

To obtain this exemption, the petitioner must show, as required by § 11.81(d), that granting the request is in the public interest, and, as required by § 11.81(e), that the exemption will not adversely affect safety, or that a level of safety will be provided that is equal to that provided by the rules from which the exemption is sought.

FAA Analysis - Public Interest

The petitioner has committed to demonstrate that all practicable actions have been taken to minimize the adverse effect on safety associated with granting of the exemption from § 25.901(c) for the 757-300/PW2000 Series Engines. If the FAA is to certify the Boeing 757-300/PW2000 airplane, making this commitment a condition of the exemption assures that granting the exemption will prove to be in the public interest. That is, any risks associated with a known non-compliance must be eliminated or further reduced wherever the FAA finds that to do so is technologically feasible and cost beneficial for the public. This has traditionally been accepted as the level of safety which is “in the public interest.” Furthermore, if bringing the airplane into compliance is found to be a “practicable action,” then this exemption would in effect be self eliminating.

The Rolls Royce RB211-535E4B is currently the only engine offered on the Boeing Model 757-300. While the risks associated with the “Uncontrollable High Thrust Failure Condition” have yet to be re-evaluated specifically for the existing B757-300/RB211-535E4, there is currently no reason to believe they are substantially different than those for the proposed B757-300/PW2000 airplane. The FAA has concluded that there is some benefit to the public in fostering fair competition in the marketplace by allowing Boeing to offer alternative engines with traditional engine control systems. If we required the PW2000 engine controls to provide a degree of redundancy beyond that of traditional engine controls, that would likely create an unfair competitive advantage for one or the other engine manufacturers. However, if we allow the PW2000 to be certificated with traditional engine controls, once the continued airworthiness risk management criteria associated with the forthcoming “Thrust Control Malfunction (TCM) Airworthiness Program” are developed, they can be applied equitably to both the Rolls Royce and Pratt & Whitney powered B757-300 airplanes.

In consideration of the above, the FAA concludes that granting this petition is in the public interest.

FAA Analysis - Effect on Safety

The petitioner has committed to demonstrate that the B757-300/PW2000 exposures and failure rates are such that this airplane should not exceed the known average per flight hour risks of comparable existing transport category airplanes. Making this commitment a condition of this exemption, in combination with the condition to minimize that risk, means that granting this exemption should not adversely affect and, in fact, should improve the average per flight hour risk within the current transport airplane fleet.

For those existing transport airplanes re-evaluated to date, the conditions under which an uncontrollable high thrust failure may jeopardize the safe operation of the airplane are limited to specific aborted takeoff or approach and landing scenerios. Given that these scenarios occur, there is still a low probablity that any serious injury will result. This limited exposure, in conjunction with the historically low occurrence rates, make this a relatively low per flight hour risk. This assessment is supported by the fact that the 1997 Saudi Arabian Airlines Boeing 737-200 accident is the only one attributed to these types of failures and there were no serious injuries in that accident.

It is the spectre of this low per flight hour risk accumulating indefinitely on many, if not most, existing and future transport airplanes that is the primary concern driving development of the FAA "Thrust Control Malfunction Airworthiness Program". To date, corrective actions under 14 CFR part 39 have only been deemed warranted when the uncorrected risks for a particular type design were considered significantly greater than the known average risks within the transport fleet. Since the conditions and limitations of this exemption require that the Boeing Model 757-300/PW2000 be expected to have an uncontrollable high thrust failure rate over three times better than the current fleet average, the impact of adding the B757-300/PW2000 fleet hours to the overall transport fleet exposure should be insignificant. Furthermore, if as part of the "Thrust Control Malfunction Airworthiness Program" the FAA determines that additional generally applicable precautions must be taken, including perhaps some future introduction of a compliant design, these will further minimize any cumulative risk impact of granting this exemption.

This exemption inherently implies a somewhat greater hazard than full compliance with § 25.901(c). This is why the FAA intends to bring the transport fleet back into full compliance as soon as practicable. Nevertheless, the fact that the per flight hour risks associated with this non-compliance are low allows us to develop a well considered recovery program to assure we don't introduce a worse problem than we are trying to solve and that this recovery program is clearly in the public interest.

In consideration of the above, the FAA concludes that granting this petition will not adversely affect safety.

The Grant of Exemption

In consideration of the foregoing, I find that a grant of exemption is in the public interest and will not adversely affect safety. Therefore, pursuant to the authority contained in 49 U.S.C. 40113 and 44701, delegated to me by the Administrator, The Boeing Company is granted an exemption from § 25.901(c) to the extent necessary to allow type certification of the Boeing Model 757-300 airplane with Pratt & Whitney 2000 series engines without an exact showing of compliance with the requirements of § 25.901(c) as they relate to single failures resulting in uncontrollable high thrust conditions. For the Model 757-300, this exemption is subject to the following conditions and limitations:

1. The Boeing Company must demonstrate, in accordance with an FAA-approved “Airworthiness Assessment and Risk Management Plan,” that all practicable actions have been taken to minimize the adverse effects on safety associated with granting this petition. These must include, but are not limited to, practical actions to eliminate or further reduce the risks by improving designs, procedures, training and instructions for continued airworthiness.
2. The Boeing Company must demonstrate, in accordance with an FAA-approved “Airworthiness Assessment and Risk Management Plan,” that the risks associated with exempting the “uncontrollable high thrust failure condition” from the single failure provisions of § 25.901(c) are no greater for the proposed 757-300/PW2000 model(s) than those generally known to exist for comparable airplanes within the current transport fleet. Acceptable risk for this provision can be characterized as:
 - a. The airplane complies with § 25.901(c) for any foreseeable uncontrollable high thrust failure conditions in flight, except possibly during approach below 400 feet; and
 - b. The expected frequency of occurrence of the uncontrollable high thrust failure condition is less than once per ten million airplane operating hours.
3. The following “Note” will be added to the airplane Type Certification Data Sheet for any airplane certificated under this exemption:

“The FAA has concluded that the occurrence of any uncontrollable high thrust failure condition, or any of the associated causal failures listed within Boeing Document (reference tbd), “may endanger the safe operation of an airplane” and hence are reportable under §§ 121.703 (c), 125.409 (c), and 135.415(c).”

In support of this “Note”, the Boeing Company must develop and obtain FAA approval of “Boeing Document (reference tbd)” which lists those failures that can contribute to or cause an uncontrollable high thrust failure condition covered by this

exemption. This document shall then be made available as part of the instructions for continued airworthiness. Further, the failures listed within this document shall be added to the list of reportables under § 21.3 for any airplane certificated under this exemption.

4. The granting of this exemption does not relieve any regulatory obligation to identify and correct unsafe conditions related to uncontrollable high thrust failure conditions.

Note: Additional background and guidance regarding these provisions are provided in FAA Letter 02-112-02, dated October 19, 2001.

Issued in Renton Washington on June 4, 2002.

/s/Ali Bahrami

Ali Bahrami

Manager

Transport Airplane Directorate

Aircraft Certification Service